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INTRODUCTION TO SOCIOLOGY. VI.

PART III. GENERAL STRUCTURE OF SOCIETIES.

CHAPTER VI.—*Continued.*

SECTION II. THE LIMITS OF STRUCTURE AND OF ORGANIC LIFE.

THE problem of the natural distribution of the human species is a sociological problem. Its data are related at once to the different environments and to the varieties of populations, to physical nature, and to man. Zoölogical biology in general rests upon the double consideration of the living being and its environment. The human species forms a part of this chain of living beings. It is therefore necessary to interpret the laws concerning the distribution of the human species over the earth, at first, entirely through biology.

In its metaphysico-positive transition the philosophy of history, disdainful of humble realities, had ended in these latter times only in some contradictory absolutes, to every one of which each school exclusively attached its preferences, either to the environment or to the race. The race itself remained a vague expression. Indeed, it could be conceived of only as a variety of a single species. Thence recurred the problem of the origin of these races and of these varieties. If the race is a historic product, it can evidently disappear from history at a certain time in the same manner that it has appeared. In his *Philosophie der Geschichte* Lassaulx attempted to resolve the difficulty by saying that the human kind, in its corporeal and intellectual nature, is nothing else than the unity of the first man scattered into pluralities, and that the first man is nothing else than the plurality, still concealed in unity, of all those who shall proceed from him! Lazarus Geiger, in *Zur Entwicklungsgeschichte der Menschheit* (Stuttgart, 1871), applied this pretended universal law of the development of humanity, at once nature and mind, to the science of language.² This formula, in appearance conciliatory, was in

²*Idem, De l'origine et de l'évolution des langues.* Stuttgart, 1862; 2 vols.

reality only a play upon words—one of the able and profound mystifications in which the metaphysicians were for centuries past masters. It was not through a generalization from observation, but through a simple phrase, that was resolved, in a simply formulated synthesis, the problem of monogenism and polygenism, connected with that of the race and the environment, as well as with that of language. The conciliatory synthesis was so little real that in Geiger's theory of language, for example, the organism and the environment ended by being lost to view, and the connection between the sound and the idea was considered as entirely artificial, arbitrary, and conventional.

I have already indicated that positive sociology is not directly interested in the solution of the controversy between monogenism and polygenism. Questions of absolute origin are outside of its proper domain. In the problem which occupies us they are important only from the point of view of the historic evolution of the theories themselves, and in so far as the actual limitations of these last go to show us in an evident manner that the race and the environment, the self and the non-self, reduce themselves in sociology, and in pure philosophy in general, to the relations, connections, and laws whose formula, precisely so far as it is evolved from the latest scientific data relative to the distribution of the human species, has nothing of the absolute. It is therefore only from this historic point of view that we recall the two great scientific schools which arise, the one from monogenism and the other from polygenism.

Both, in fact, admit the specific unity of humanity. The common and essential characteristics of structure and of life make from the several human varieties a homogeneous and single specific type.

Charles Darwin, and especially Haeckel, are monogenists. According to them, the races are derived variations; they are secondary. According to Pritchard and Topinard, we comprehend under the name of races all collections of individuals presenting more or less common characteristics which are transmissible through heredity, the origin of the characteristics being put aside and reserved. The race is a sub-product of the species.

All men are of the same species in so far as they present among themselves only quantitative differences, relatively secondary to their structure and to their essential qualities. They may be of different races by reason of certain variations equally quantitative, but always secondary, though transmissible through heredity.

It is to be observed, first of all, that the distribution of the human races within certain organic and geographic limits is less circumscribed than the distribution of animals in general. This fact results precisely from the principle that man, from the point of view of natural history, constitutes quite a unique zoölogical species, comprehending a great number of varieties. There is unity of constitution and unity of composition of this constitution. All of the human varieties are capable of uniting among themselves and of producing offspring. Was there at first a single couple, one sole center of creation? Of what importance is it to ask? What is certain is that the various conditions of civilization have engendered, and still engender—for example, among the Anglo-Americans—some variations just as among the domestic animals. Natural evolution has always followed the same laws. The differentiation is derived from the primitive homogeneity.

The monogenist's hypothesis and the formation of races are completely explained by Darwin and his school according to the simple play of natural laws. The factors in the formation of races, as the factors in the formation of species, are, first, variability, which is a general phenomenon among all organic beings, together with heredity, no less general, which fixes and transmits the variations; and, lastly, natural selection, which assures continually the survival of the fittest, *i. e.*, those which are best able to adapt themselves, actively or passively, to the physical or social conditions of the environment.

This explanation appears so much more reasonable in reference to the human species, that the objection raised by M. de Quatrefages against natural selection, which according to him can produce races, but not species, does evidently not apply to the human species, which exactly divides only into races and varieties entirely capable of uniting among themselves, and of giving

birth to fertile offspring. The Darwinists, however, cite some cases of fertile unions among different species, vegetable as well as animal. But the question whether the human species is the result of a natural selection, without being indifferent to sociology, is connected with it only very indirectly. Sociology has for its object only the human societies, comprehending their environments in so far as forming a special superorganic whole.

The action of natural selection upon the formation of species and races is, according to Darwin, also favored by isolation, and this accords with our previous observations. This factor is especially important when it is a question of the formation of distinct social groups, but of a single species, such as the human species.

In South America, in going from north to south and from east to west, it is evident that the alterations in the conditions of life have modified the organisms in the several regions in such a way that they *now* form different races and even different species. It is further clear that in the isolated districts, however small they may be, the animals are modified almost always slowly. I am not able to decide how far this differentiation is due to the nature of the different conditions, however slight, to which the organisms are exposed, or at least unable to decide to what extent it depends upon intermixture. Very slight differences, considered by the systematists as having no importance in the structure, are found to be continually important from the functional standpoint.¹

Let us notice the prudent reserve of Darwin upon the question whether these variations are due to the conditions of environment or to the conditions of intermixture, *i. e.*, relative to the very nature of the individuals. Here is the point of departure of a partly new theory, that of Weismann—the theory which will permit us finally to reduce the problem, in its purely relative and positive conditions, to the simplest terms. Let us point out and note further that if, as it is certain, isolation produces human varieties and races, the inverse phenomenon—that is to say, the continued transformation, with the progress of civilization, of the greater part of the natural barriers of communication in equally natural ways, and the gradual lowering, at least relatively, of the social energy of those barriers which do not undergo this

¹ CHARLES DARWIN, *Life and Correspondence*, Vol. II, p. 492 (French translation).

transformation—must therefore naturally tend to the mixture of races and to a more homogeneous adaptation of the species to the different conditions of the plant, through the progressive acquisition of qualities more and more special and complex, but also more and more common to the several groups.

In opposition to the school of Darwin, polygenism is represented, in the philosophy of history, notably by Kolb who, in *Culturgeschichte der Menschheit*, admits a great number of primitive races. In this respect he agrees, as we have seen, with Gumpłowicz. Blumenbach reduces the number of absolutely original races to five. Kolb rejects monogenism, chiefly for the reason that man would be incapable of adapting himself to the divers climates, and that consequently some distinct centers of creation were necessary. Adaptation, he thinks, becomes partly possible only for the civilizations already very advanced and prepared by great resources for escaping more or less from the external influences. According to him, the special environments correspond therefore to special races created in these environments.

Such is the explanation of a rational philosopher. It is, in fact, very complicated. It necessitates as corollary the explanation of the fact that these special and local creations have been able, however, to contribute to the formation of a specifically single type, notwithstanding its accessory variations. This explanation the naturalist partisans of polygenism appear not at all capable of furnishing. See, however, the principal arguments produced by one of them, Burmeister, in his *Histoire de la création*.¹ According to him, the influence of environments, from the point of view of the formation of species and races, is not the same in so far as one applies to the man that which has been observed among animals. The races of domestic animals, particularly in a certain climate or upon a certain soil, are not slow to degenerate when they are transported to other climates and other soils. However, they conserve a certain originality and do not take completely the character of the race-stock which primarily inhabited the new environment. "*As to the human kind,*

¹Fifth edition, 1854, pp. 564-68.

the result is different, because the national type does not degenerate when it is transported from the original to another country." A pure Jew never becomes a German or Russian, any more than a European becomes a negro.

Why, then, would the descendants of Adam, by whatever means they came to possess a particular type of race, be transformed into negroes, Papuans, Caribs, Malays, or Mongolians? On the contrary, the explanation is simple if we admit that at the origin, in the several centers of creation, the individuals of the same species have been subjected, from the moment of their first appearance, to different reactions from outside, which have produced their varieties of color, stature, structure, features, extremities, and hair. According to the opposite opinion, in that which concerns the color, for instance, it would be necessary that all of the tints be derived from one fundamental tone. But then, why are the Australians and Papuans black, while the inhabitants of the islands of Réunion and the Friendly Islands very near the equator have remained a yellow-brown? Why in America have all of the natives from north to south a red-brown color, while upon the eastern hemisphere white, yellow, brown, and black populations live quite near each other? Monogenism proceeds, at bottom from the inveterate prejudice of the Mosaic account of creation which has inculcated the legend of the unity of origin. What miracles, what strange decrees of chance, would not have been necessary in order that a single couple might have, in the space of four thousand years, a progeny of a billion souls, which setting out from a single point, should have scattered themselves (by what means?) upon the distant islands, upon the divers points of the great American continent so remote from each other! Why should they not have remained together in the fertile plains where they first saw the light? Why should they have preferred to betake themselves to the icy regions of the poles? What was the cause of the development of such different languages, whose fundamental elements are partly heterogeneous? How could one nation, having spoken first the language of its ancestors, come to adopt later a language entirely different?

The doctrines of variation, of heredity, and of natural selection respond perfectly to these objections. The natural laws which explain the formation of the human varieties explain also the formation of new varieties, generally less distinct, which result from their mixture. But, on the other hand, it is necessary to acknowledge that neither the variability of the human species, nor heredity, nor selection proves *historically* the unity of origin of this species. So we have seen in these latter times the two contradictory terms of the problem, presenting themselves anew

to the antagonists in a more energetic, and also a more and more precise, fashion than formerly.

The question as it actually presents itself is this: Does the environment act upon the germ in such a way that the acquired characteristics are transmitted by heredity? Let us note that in this term "environment" it is necessary to include even the somatic cell in which the germinal plasm is contained. Here the question is narrowly presented in its irreducible elements. We see the path traversed by science and philosophy since the time of Hippocrates and Herodotus, *i. e.*, during about twenty-five centuries.

To this question, as formulated by the most recent biologists, we are able to give with Weismann¹ the following general response:

The aptitude for the existence of organic species does not depend solely upon the internal powers of the species. It depends further upon the relations of the species to the exterior world, and it is here that the necessity for adaptation is found. This adaptation, fixed by heredity, *limits* their structure and their growth.

This law applies to the human species, and also to the varieties of human species. It is not an inflexible and absolute law, but is founded upon the constant relations between the internal structure of the species and race, on the one hand, and their environment, on the other. Setting aside any question of first cause or of finality, this law suffices for the explanation of the sociological phenomena of variation, repetition and imitation, heredity and selection, and consequently of the adaptation of the several societies to their respective environments. Weismann unfortunately, as we shall see, partly loses sight of this relative character.

The general variability of organisms, heredity, natural selection, and, as a consequence, the continual adaptation to the environment—and I would add that of the environment to the organisms—suffice to explain their form and their evolution. They suffice similarly to explain the most general laws of distribution of the human species and races over the surface of the globe.

¹ *Essais sur l'hérédité et la sélection naturelle; La vie et la mort.*

The general variability of organisms has no further need of being demonstrated. It is the constant result of certain relations between their internal structure and their external environment. For illustration, the ordinary horses imported into the Falkland Islands produce from the first generation smaller offspring, and after a few generations the species degenerates altogether. This alteration of structure is in connection with the bad food and humid climate of the country.

In primitive or other human societies whose climatic and alimentary environment is favorable, there will be brought about in the genesial relations some advantageous variations, in the sense, for example, of an extension and consolidation of the family life. Notably more value will be attached to the preservation of children than in a society where this preservation constitutes a disadvantageous burden. Children will be the object of more care and of more extended education. Also more care will be given to the women and to the old men.

What is it necessary to understand by "heredity" in the case of horses and men? Is it necessary to comprehend, as is generally supposed, that the characteristics acquired by the individual under the influence of the environment are fixed and transmitted hereditarily in the species? According to Weismann, the acquired characteristics are not transmitted; at least, nothing so far proves such transmission. There are merely some advantageous and disadvantageous modifications in the several aptitudes of the germinal plasm of each organism. For instance, in the case of the horse of the Falkland Islands, in an unfavorable climate and with deficient alimentary conditions, the horse suffers not only in its structure, but also in its germinal cells. There is a diminution in the size of the cell, to which must be added insufficient nourishment during growth; but there is no transmission, through the germinal cells of certain peculiarities which are manifested first among adult animals under the influence of the climate. The degeneracy of the species under these conditions is due entirely to natural selection, which operates in the sense of the preservation of the smallest horses, that is, of those whose germ has been enfeebled. This explanation is conformable to the conclusions

of Virchow, who in his *Pathologie cellulaire* shows that the cell is not only nourished, but that it nourishes itself by its own activity. Furthermore, Weismann, in accordance with modern embryology, brings out in connection with the segmentation of the egg and the phenomena of consecutive development, the proof that it is in the cells themselves that we find the reasons for the different forms of reproduction.

Therefore the theory of natural selection suffices to explain the formation of species and races. It has for its basis the variability of organisms. This variability brings about great preparations for the changes in their conditions of existence. These new conditions impose upon the organism new exigencies to which they are obliged to yield in order to exist. Then intervenes a progressive and continued selection which so acts among the modified organisms that only those survive which are the better adapted to the modified conditions of existence. Selection continuing in this way, the differences between the primitive forms and the derived forms tend more and more to accentuate themselves. They become differences of race, and even of species.

Weismann adds :

These modifications in the conditions of existence, as well as in those of the organism, must be effected very slowly and by short steps. At any moment in the whole phenomenon of transformation the species must live insufficiently accommodated to the conditions of existence. A sudden brusque transformation cannot be conceived, for the reason that it would render the existence of the species impossible.

This law of constant and general equilibrium accompanies at each step all of the movements and all of the variations of individual organisms, and we shall see it operating also among the social organisms. We shall see, in the proper connection, that it is these same laws that we must employ as the scientific bases of the limits in time and space of the development of the social organizations. Thus the theory of frontiers constantly follows a line parallel to that of the theories of the natural sciences in general.

In reality, heredity is not abolished, let us truly remark, but it is explained through the continuity of variations, in the sense

indicated by natural selection, *i. e.*, through variations in the most advantageous direction for the preservation of the organism in its relations with the climatic and alimentary environment, etc. It becomes definitely a veritable phenomenon, not individual, but collective and social. Weismann has not sufficiently noticed that the difference between his doctrine and that of Darwin and Spencer is not so radical *in its results* as he thinks.

The variability of organisms, so far as it results from that which precedes, is therefore limited at each moment of time by the very nature of the organisms and by the conditions of the environment. Variability never preponderates, even in the interpretation of Weismann, over the conservative and co-ordinative function of continuity; *i. e.*, for short, over heredity. In the active substance of the germinal plasm there is always a part which remains unmodified and fixed, when the germ is developed into an organism. This more or less considerable residue serves as a bond between the past, present, and future. It furnishes the basis of the germinal cells of the new organism, and thus one after another of all those which shall follow. There is therefore uninterrupted continuity of the germinal plasm from one generation to another. This continued transmission of the ancestral germ constitutes the function of heredity. There are, therefore, order, fixity, persistence, and continuity in variability itself. This explains the remarkable persistence of the social and organic types. Their fundamental structure is a heritage. The germ of this structure is itself the product of a long natural selection which is fixed, and which neither the environment nor the will can modify in an absolute fashion, although theoretically, or rather from the standpoint of the purely rational and negative critic, the bases of this structure should be considered false.¹ Weismann explains this persistence of heredity in the following passage:

The physical constitution of the species depends upon the *ensemble* of hereditary characteristics adapted to each other and so combined as to form a harmonious whole. It is this peculiar nature of the organism which per-

¹ Some *disharmonies* presented by the learned ELIE METCHNIHOFF in his interesting work, *La nature humaine* (Paris, 1903), are striking illustrations of the theories of Weismann relating to selection and heredity.

mits it to react upon the external influences in a manner different from that of any other structure, which is the reason that it cannot modify itself, no matter what its form, and which demands that there be quite numerous possibilities of very definite variations. It also renders possible that certain peculiarities in the constitution of a species may disappear and be replaced by others. We cannot discover varieties of vertebrates without the vertebral column or fixed axis, not because the vertebral column is indispensable as a support for the body, but rather because this form has been transmitting itself from time immemorial, and on that account has become so fixed that it is no longer able to be produced with sufficient variations to menace its existence. The idea of the origin of the hereditary variability through the amphigonic reproduction clearly explains how the oscillations of an organism may be in a certain measure purely superficial, and so explains the impossibility of the fundamental bases which have been so long acquired.¹

These biological considerations are relatively common to the structure of societies. They confirm our sociological theories, to which we shall have to return in due time, relating to the greater fixity and stability of forms, and the most general social functions, and especially of the most anciently constituted forms in each function. They are likewise the primary explanation of the phenomena and laws of correlation and harmony, which at each moment and in each civilization are revealed to us through the social organizations considered in their *ensemble*, and they also serve as an interpretation of the frequent incoherences of social organization.

That which Weismann calls "the impossibility of the fundamental bases" explains how the biological organisms are naturally limited in their form and growth. But even in biology it would not be necessary to attach an absolute character to this impossibility. For the strongest reasons it is necessary to avoid this in sociology, where even the most fundamental forms are only relatively more fixed than those which are more superficial and more recently acquired. Some sociologists, as A. Loria, have deduced too rigorously from a sociological principle, itself viewed in a too inflexible manner, that societies also are not able to exceed certain limited forms. The profound and learned Italian sociologist especially applies this principle to the eco-

¹ A. WEISMANN, *La signification de la reproduction sexuelle pour la théorie de la sélection naturelle*.

nomic forms which, among other things, are considered by him, and with reason, as fundamentals. Others, with still more rashness, extend the principle to the entire social organization.

We shall have to examine this *hypothesis*. Let us say, however, at present that, even from the economic point of view, the superiority of complexity and of malleability which characterizes the social organisms does not permit us to predict what would be the limits of their variations and of their material or social development. At most we are able to assign to their development some limits from the point of view of extension in space, but not at all from the intensive point of view. However, we shall have to take account of the biological data in this connection; for although the social types may be less inflexible than the specific types of organisms in general, the laws of social structure and growth have in biology partly their point of departure and their primary philosophy, of which the sociological philosophy is but the extension to special and more complex cases, requiring partly a new interpretation.

Let us therefore indicate briefly these biological limits of structure and growth among organisms generally, in order that we may not lose sight of their total or partial applicability, possible or not, to the structure and growth of societies.

Organisms are altogether limited in space and time. Not only do they attain only to certain dimensions, but they likewise live only a certain length of time. Many animals—man, for example—reach their normal size long before their natural death. Everywhere organisms attain a maximum of size which is never exceeded. We shall see later that the number of organisms of each species, and especially of the human species, is limited by the very conditions of the social structure.

What is the cause of this structural limitation? Is it an exterior or interior obstacle? This problem in its more simple terms is one of those which bring up that more complex problem of the social frontiers. How is it settled by the biologists?

They explain it first by a general law of mathematics and physics. There is a constant relation between the increase of mass of all bodies and that of their surfaces. This law applies

likewise to the dimensions of organisms, but under special conditions.

In individual organisms the size of the structure depends principally upon heredity. The quantity and quality of the alimentation occasion only slight variations in the size. The individual dimensions are above all fixed from the beginning. From the egg whence the individual develops itself they are fixed, circumscribed by the numeric and chronological limits in the rapidity of formation of the cells.

Why, now, are these divers limits in the multiplication of the cells variable according to the organisms? Here again we can refer to the law of proportionality of the surface to the mass, and to the physiological conditions of opportunity. Says Weismann :

In fact, when a particular size is more favorable to the development of a certain plan of construction, there has resulted a process of selection which has brought the fixation for each species to an average size, oscillating within more or less extended limits. This average size is transmitted by heredity from generation to generation, and the model is already contained in the germ of each individual.¹

It is the same with the *duration* of organisms. Weismann shows us clearly that natural death is only a phenomenon of adaptation useful to polycellular organisms, and therefore, on the contrary, that simple cells may be immortal. The germinative cells (such as eggs and spermatozoids) which, differentiated in the multicellular organisms from the somatic cells, alone conserve immortality. For the unicellular animals there can be no question of natural death. Their increase is produced by division. The new cells are identical with the old ones. Among these animals there are neither older or younger beings. The myriads of cells are all equally old and equally young, like their species. Their life is indefinitely extended into the past and future through incessant divisions.

The limitation of the individual by death is therefore not a constant law inherent in the very essence of life. It is only a necessary adaptation, and this is realized only in the superior

¹ *Limites de la croissance et de la durée de la vie.*

organisms which attain to, but do not go beyond, a certain structural development incompatible with their immortality.*

When the organized mass which formerly produced the phenomena of life produces them no longer and will never again produce them, it is death. . . . The duration of life is exactly adapted to the conditions of life. It is lengthened or shortened, in the course of a formation of a species, according to the conditions of life of the species. In a word, it appears absolutely as an adaptation to the conditions of existence.

Life is therefore an equilibrium of the organism at once internal and external, an equilibrium at once stable and mobile.

But societies are the rashest, most complex, and most plastic organisms, and they are the most capable of continued adaptations. The result is that their structure, their extent in space, and their duration in time may be alike more extended and more durable by means of adapting themselves more and more in space and time to the conditions of social life. Societies are naturally neither mortal nor immortal, but they may extend and prolong their growth within limits less narrow than any other organism excepting the unicellular organisms. Theoretically they can accomplish the same result through their complexity that the unicellular organisms accomplish through their simplicity.

Hence in the individual organisms the limits of structure and life are determined by the conditions of life. The latter, through adaptation and natural selection, fix the aptitudes of the germ, and afterward of the structure and life which are transmitted and conserved through heredity. The germ of organisms is therefore not the absolute beginning of them. It is the product of a relation, of continued natural selection, fixed and transmitted through heredity, of an adaptative, that is to say, of a constant static equilibrium in its mobility, which necessarily implies two terms, a subject and an object, the one capable and the other susceptible of adaptation.

We see, then, in the last analysis where the study, from the very first so obscure and complex, has led us, concerning the relations of the external environment to the human species, from the standpoint of the natural distribution of this latter over the

* *La vie et la mort.*

surface of the globe; that is to say of course its natural limits and frontiers.

This theoretical antagonism which we have observed in all of our doctrinal exposition, and which a little while ago was established in a more or less metaphysical and absolute fashion between the self and the non-self, between mesology and anthropology, between the environment, especially the climate, and the race, is scientifically reduced to the relative data whose point of departure is the nature of the germ and its development in connection with the conditions of existence, by way of natural selection, heredity, adaptation, either continuous or discontinuous. If continuous, it implies continuation of growth, and if not, it implies death.

The fact that every society contains in itself its organic, inorganic, and psychical environment does not alter this point of view, because every society, by the mere fact that it is more or less limited, is necessarily in correspondence with other social and physical environments. Even the universal society, humanity, in its relations with the external environment remains still subject to the planet.

Unfortunately, the metaphysical spirit is itself an inherited peculiarity which, in spite of its degeneracy, is difficult to cast off. Hence it is that Weismann in his turn, after having contributed so much to perfect the theory of natural selection, heredity, and adaptation, seems to us to lose sight of the constant relativity of the phenomena which he has studied and, from the logical point of view, to revive an absolute which is irreconcilable with his own observations. The example is interesting because it helps us to grasp the fundamental distinction which exists between positive philosophy and metaphysical philosophy, and to drive the latter from its last intrenchment. By a purely formal and metaphysical subtlety, Weismann, who has so well demonstrated that the formation of the germ is itself the result of a selection, of an adaptation—*i. e.*, of a *relation* between the being and its conditions of existence—finally restores to the germ this attribute of first causality which the theologians and philosophers had successively attributed to the

creative divinity, and afterward to the individual and to the species or race, or, in a manner equally exclusive, to the environment. The logic in this connection recalls the best days of the scholastic with his distinctions between the *causa efficiens*, first causes, second, final, real, formal, etc.

According to Weismann :

If a phenomenon is produced only under certain conditions, it does not therefore follow that the conditions are also the *cause* of the phenomenon. The warmth of the setting hen is a condition without which the young chick cannot be developed, but we should have difficulty in maintaining that it is to the heat that the eggs of the hen are indebted for the faculty of becoming chickens. This faculty is evidently altogether the outcome of an infinitely long phyletic development, finally terminating in a physico-chemical structure of the egg and spermatocytic cell, so that from their union the result must be a chicken, and not a goose or duck, on the supposition of the accomplishment of certain conditions required by this individual—conditions of development among which heat also figures. In a word, it is therefore the physical nature of the egg that is the cause of the development of the chicken.

Weismann gives still other examples, in support of the conclusions of his formal logic. An ivy branch may be inverted in such a way that the root exposed to the light will produce leaves, and that the old part of the leaves will produce roots. According to him, this double adaptation has for *cause*, not the influence of the external causes *in connection* with the nature of the ivy, but the peculiar nature of the latter.

If the tree frog changes in color—if it is pure green while it lives upon green leaves, and from brown to black when placed in a somber environment—this change of color depends upon a very complicated reflex mechanism. In fact, the modifications of the coloring cells of the skin are not due to differences in the illumination upon the skin through the light, for the reason that blind frogs do not react from the changing illuminations of the environment. There is, according to him, but one possible explanation—that of the process of natural selection according “to the differences in the reaction of the *organism in possession of itself*.” But how can a reflex action be explained without the outside stimulation? Here is, indeed, the revival of the indi-

vidual free-will, the life of the organism considered as having its first cause independent within the organism itself. Weismann recognized, however, that in the above example of the tree frog it is a question of adaptation. Why, then, contend that the environment in connection with the organism is not a modifying condition to which the tree frog adapts itself, as well as that the constitution of the latter is a condition of this same modification?¹

After that, in another of his essays, Weismann comes clearly to concede that the external environment may be regarded as the *indirect cause* of structural modifications :

If among moths the outer side is gray like the wall upon which it sleeps during the day, and if among butterflies the under sides of the wings drawn back in repose possess a protective coloration, that is not at all the direct result of the influence of the wall; but if it is brought about naturally, it may be *indirectly* the result of the wall. . . . We ought not always to be forced to return to this A B C of our knowledge concerning the causes of transmutation. . . . If Detmer had taken this precaution, he would have guarded against adding this phrase as a résumé of the experiments which he has invoked in vegetable physiology, viz.: "It is possible in certain cases, as we have seen, to modify by experimentation the anatomical structure of particular organs of plants." In this case, there is undoubtedly a *relation* between this modification and the external influences. *These latter act as a cause.* The anatomical transformation of the elements of the plant is the result of this cause. A little more logic would have guarded him against this, for his conclusion is due solely to confounding the *real cause* of the phenomenon with one of the *conditions* in favor of which it may be produced.

Here then is a new distinction, that between the *real cause* of a phenomenon and the condition without which the phenomenon could never be produced. The latter is not a real cause. Let us ask: Are not the causes of a phenomenon the conditions which in a constant and necessary manner accompany its production? The tendency of Weismann to introduce the methods of formal logic into the natural sciences is most deplorable.

Nevertheless, Weismann, little at ease in his casuistry, adds anew his former distinction: "We have here to do with adaptation and not at all with the result of direct action;" with adaptation, that is to say, with the *processus* of selection based upon general variability. What does this mean, if not that the

¹ WEISMANN, *Des prétendues preuves botaniques de l'hérédité des caractères acquis.*

first cause and the final cause ought to be alike comprehended within the scientific domain? Science investigates and recognizes only the conditions of realization among phenomena. These conditions are remote or near, direct or indirect, according as they directly accompany or precede, with or without intermediation, the appearance of the phenomenon. Among the conditions of the structure and life of organisms some are internal and others external. The adaptation of the first to the second, and the modifications which are brought about in the structure and life, are conditioned by these two factors. It is this continued correspondence which constitutes structure and life.

The egg of a hen may be changed into an omelet as well as into a chicken according to the environment in which it is placed. Adaptation involves the environment as well as the aptitude.

G. DE GREEF.

BRUSSELS, BELGIUM.

[*To be continued.*]